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Claims

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1. (Currently amended) A method of transmitting data in a data communications network, comprising the steps of:

(i) establishing a communications link between a transmitter and a receiver through a TCP handshake, the communications link having a TCP congestion window set to an initial length;

(ii) transmitting data packets from the transmitter to the receiver;

(iii) detecting a missing packet at the receiver;

(iv) sending a negative acknowledgment from the receiver to the transmitter for the missing ~~data~~ packet, the receiver being unresponsive to ~~receipt of any other packets from the transmitter~~ any packets from the transmitter unless the receiver detects the missing packet;

(v) decreasing, at the transmitter, the length of the congestion window in response to receipt of the negative acknowledgment; and

(vi) re-transmitting the missing packet.

2. (Original) A method according to claim 1, wherein up to four duplicate negative acknowledgments are sent from the receiver.

3. (Original) A method according to claim 1, wherein the congestion window is halved at step (v).

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4. (Currently amended) A method according to claim 1, further including a step of setting a round-trip timer at the transmitter upon transmitting the data packet, and a step of increasing the congestion window in response to the round-trip timer.

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5. (Currently amended) A method according to claim 4, wherein the step of increasing the congestion window ~~is increased~~ increases the congestion window if no negative acknowledgement is received upon expiry of the ~~return trip~~ round-trip timer.

6. (Original) A method according to claim 5, wherein the congestion window is

doubled.

7. (Currently amended) A method according to claim 1, further comprising a step of periodically sending a keep-alive request from the transmitter to the receiver, whereupon a re-transmission time-out timer is set, and a step of generating, at the receiver, an acknowledgement in response to the keep-alive request, the receiver being responsive only to the missing ~~data~~ packet and the keep-alive request ~~and being unresponsive to receipt of any other packets from the transmitter~~.

8. (Currently amended) A method according to claim 7, ~~wherein~~ further comprising a step of determining, at the transmitter, ~~determines~~ if an acknowledgment to the keep-alive request is not received before expiry of the re-transmission time-out timer, whereupon the transmitter backs off for a predetermined period.

9. (Original) A method according to claim 1, wherein the congestion window is decreased in response to three duplicate negative acknowledgments.

10. (Original) A method according to claim 1, wherein the data communications network in an internet.

11. (Currently amended) A method for error recovery in a data communications network where data is transmitted as a sequence of data packets sent from a transmitter to a receiver, a communication link between the transmitter and the receiver being established through a TCP handshake, comprising the steps of:

detecting a missing packet at the receiver;

sending a first negative acknowledgment from the receiver to the transmitter for the missing packet, the receiver being unresponsive to ~~receipt of any other packets from the transmitter~~ any packets from the transmitter unless the receiver detects the missing packet;

setting a missing-packet timer at the receiver upon sending the first negative acknowledgment; and

where the missing packet is not received at the receiver in response to the

first negative acknowledgment before expiry of the missing-packet timer, sending a ~~further~~ second negative acknowledgment.

12. (Previously Amended) An error recovery method according to claim 11, wherein the step of detecting a missing packet includes the step of detecting a missing packet according to a gap in sequence numbers of the stream of data packets, the step of setting a missing-packet timer settings a missing packet timer when the gap is detected.

13. (Original) An error recovery method according to claim 11, wherein up to four negative acknowledgments are sent from the receiver to the transmitter before expiry of the missing-packet timer.

14. (Original) An error recovery method according to claim 11, wherein the missing-packet timer is cleared upon receipt of the missing packet at the receiver.

15. (Currently Amended) A method for congestion control in a data communications network where data is transmitted as a sequence of data packets from a transmitter to a receiver, a communication link between the transmitter and the receiver being established through a TCP handshake, comprising the steps of:

setting a TCP congestion window to an initial size, the congestion window relating to a transmission rate over the network;

transmitting a data packet from the transmitter to the receiver;

setting a round-trip timer at the transmitter upon sending the packet;

sending a negative acknowledgement for a missing packet from the receiver to the transmitter, the receiver being unresponsive to ~~receipt of any other packets from the transmitter~~ any packets from the transmitter unless the receiver detects the missing packet;

increasing the congestion window if no negative acknowledgment for the missing packet is received before expiry of the round-trip timer; and

decreasing ~~the length of~~ the congestion window if the negative acknowledgment for the missing packet is received at the transmitter.

16. (Original) A congestion control method according to claim 15, further including a step of empirically determining the round-trip time.

17. (Currently amended) A congestion control method according to claim 16, further comprising the step of sending a round-trip time update request to the receiver, the receiver being responsive only to the missing packet and the round-~~up~~ trip time update request ~~and being unresponsive to receipt of any other packets from the transmitter~~.

18. (Original) A congestion control method according to claim 15, wherein the congestion window is doubled, and an interval between transmission of subsequent data packets is decreased, upon expiry of the round-trip timer.

19. (Previously amended) A congestion control method according to claim 15, wherein the step of increasing the congestion window includes the step of multiplicatively increasing the congestion window if no negative acknowledgement for the missing packet is received before expiry of the round-trip timer.

20. (Currently amended) A congestion control method according to claim 15, further including steps of sending a keep-alive request from the transmitter to the receiver, and setting a re-transmission time-out timer to detect a re-transmission time-out, the receiver being responsive only to the missing packet and the keep-alive request ~~and being unresponsive to receipt of any other packets from the transmitter~~.

21. (Original) A congestion control method according to claim 20, wherein the congestion window is set to one for a back-off period if no acknowledgment is received in response to the keep-alive request, before expiry of the re-transmission time-out timer.

22. (Currently amended) A data communications system employing transmission control protocol for providing error recovery and congestion control on a data

communications network, comprising:

a transmitter for sending a sequence of data packets, the transmitter having a round-trip timer that is set upon sending each data packet;

a receiver for receiving the sequence of data packets, a communication link between the transmitter and the receiver being established through a TCP handshake, the receiver detecting a missing packet in the sequence of data packets, and returning a negative acknowledgment for the missing ~~data~~ packet to the transmitter to cause re-transmission of the missing ~~data~~ packet, the receiver ~~being responsive to the missing packet and~~ being unresponsive to ~~receipt of any other packets from the transmitter~~ any packets from the transmitter unless the receiver detects the missing packet; and

means for adjusting a TCP congestion window in response to receipt of the negative acknowledgment, and expiry of the round-trip timer.

23. (Previously amended) A system according to claim 22, further including a missing-packet timer at the receiver upon expiry of which a final negative acknowledgment is sent to the transmitter.

24. (Previously amended) A system according to claim 22, further including a re-transmission time-out timer at the transmitter, the means for adjusting responding to expiry of the re-transmission time-out timer.

25. (Canceled)

26. (Previously added) A method for congestion control in a data communications network where data is transmitted as a sequence of data packets from a transmitter to a receiver, comprising the steps of:

setting a TCP congestion window to an initial size, the congestion window relating to a transmission rate over the network;

transmitting a data packet from the transmitter to the receiver;

setting a round-trip timer at the transmitter upon sending the packet;

increasing the congestion window if no negative acknowledgment for the data

packet is received before expiry of the round-trip timer; and

decreasing ~~the length of~~ the congestion window if a negative acknowledgment for the data packet is received at the transmitter

wherein the congestion window is doubled, and an interval between transmission of subsequent data packets is decreased, upon expiry of the round-trip timer.

27. (Canceled)

28. (Newly added) A system for transmitting data in a data communications network, comprising:

a receiver; and

a transmitter,

a communications link between the transmitter and the receiver being established through a TCP handshake, the communications link having a TCP congestion window set to an initial length;

the transmitter including means for transmitting data packets to the receiver;

the receiver including means for detecting a missing packet, means for sending a negative acknowledgment to the transmitter for the missing packet, the receiver being unresponsive to any packets from the transmitter unless the receiver detects the missing packet,

the transmitter further including means for decreasing the congestion window in response to receipt of the negative acknowledgment, and means for re-transmitting the missing packet.

29. (Newly added) A system for error recovery in a data communications network, comprising:

a receiver; and

a transmitter for sending data as a sequence of data packets to the receiver,

a communications link between the transmitter and the receiver being established through a TCP handshake,

the receiver including means for detecting a missing packet, means for

sending a first negative acknowledgment to the transmitter for the missing packet, means for setting a missing-packet timer upon sending the first negative acknowledgment, and means for sending a second negative acknowledgment when the missing packet is not received in response to the first negative acknowledgment before expiry of the missing-packet timer,

the receiver being unresponsive to any packets from the transmitter unless the receiver detects the missing packet.

30. (Newly added) A system according to claim 22, wherein the transmitter includes means for setting a TCP congestion window to an initial size, the congestion window relating to a transmission rate over the network, the adjusting means including means for increasing the congestion window if no negative acknowledgment for the missing packet is received before expiry of the round-trip timer, and means for decreasing the congestion window if the negative acknowledgment for the missing packet is received.